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Central Railway Club.

Advance Copy of Paper to be Presented at the Meeting of Friday, September 9th, 1910.

This paper is printed in advance for the convenience of members in their discussion of the subject; also to enable it to be presented before the Club in abstract if time prevents of it being read in full.

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ANALYSIS—CHEMICAL AND OTHERWISE

By E. M. Tewkesbury

The first glimpse we have of human society in the dim light of history is when the tribe was the only social organization. It was held together by ties of blood and family. Property was largely owned in common. The spoils of the chase, pillage in war with neighboring tribes, and the feeding of flocks were the main object of human effort.

When man ceased to roam through the forests, or over the plains, and selected and occupied fixed places of abode, a division of labor became necessary. Some tilled the soil, and others developed the mechanical arts. A diversity of labor developed the idea of private property, and made necessary the exchange of products of individual labor. In this way trade, or commerce, began. It is simply the exchange of products of one man for the products of another. In order to effect these exchanges, transportation is necessary.

The waterways were first employed for that purpose. The great cities, the marts of interchange in ancient times, were located on the seas, or on the rivers tributary thereto. The beginning of commerce was also the beginning of civilization. It first shone along the seacoast. The interiors, where no facilities of transportation existed were long enshrouded in darkness, or barbarism. Commerce slowly extended into the interior. The farther it advanced, the more necessary became an equally extended system of transportation.

First came the trail through the forest, then the public highway, then the canal, and finally the railroad. The greater part of modern history covers a period wherein there was no means of transportation, except by pack horses, carts, or wagons, and stage coaches. The first national highway was the turnpike. The most celebrated turnpike was constructed by the United States, called the " National Pike " or the " Cumberland Road." It was commenced in 1806. It extended west from Cumberland, Maryland, through Wheeling and Columbus, and finally reached Vandalia, Illinois. The plan contemplated an extension to Jefferson City, Mo., but before it was completed the era of railroad building began, and further effort in turnpike building was abandoned.

In 1825 our Erie canal was built from the Hudson River to Lake Erie, and from thence numerous canals were built in the different states. Most of them are now obsolete and long since abandoned as a means of transportation. It is hard to believe that the entire present system of railroads, which cross and recross the country with its network of steel, which climbs over or bores through mountains, which span rivers or tunnels under them, reaching almost every hamlet in this vast country, has been originated, constructed and extended within the lifetime of men now living.

The first railroad said to be the Baltimore and Ohio. That company was chartered in 1827 and construction began in 1828, but in the first two years only 13 miles were opened for traffic. There are many persons now living within the range of your acquaintance who are more than 82 years of age—this including my own father. They were living when the first mile of railroad was built, and they have seen this vast system developed, which now comprises over 240,000 miles.

When the first railroad was built, the motive power was horses and mules. It is said that even after the rails of the Baltimore and Ohio were laid from Baltimore to Ellicott's Mills it was undecided whether to use horses or sails as the motive power. Experiments are said to have been actually made with both of these instrumentalities.

A few years ago I heard a gentleman say that he personally read the annual report made by the president of the B. & O. for year 1829. In this report the president stated the number of miles built, the number of cars operated, and the number of horses employed in such operations. He also spoke of a new invention of which he had heard, made by one Peter Cooper of New York, in the way of a steam engine intended for railroad operations; but the president expressed grave doubts as to the utility of such invention. He regarded it as at least a doubtful experiment. In the year 1830 the annual report showed there was a very serious controversy going on between the engineers in charge of construction as to whether the flange of the car wheel should be on the outside or inside of the rail. The rails were made of wood and laid lengthwise on stone blocks. The chief engineer advised the use of springs on the cars. He reported that with horses that a speed of ten miles an hour had been attained. It also appeared that the company was experimenting with a Peter Cooper Engine, and the report showed one in use which had a single working cylinder of 3½ inches in diameter, and was capable of varying speed of from 5 to 18 miles an hour. All these facts

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are interesting, but the surprising interest is in the fact that these efforts originated, and these experiments made within the lifetime of men now living.

It is said the first rail of the first road was laid July 4th, 1828, only 82 years ago, by Chas. Carroll, who was one of the signers of the Declaration of Independence.

In writing of the fact that the first rail of the first railroad was thus laid by this Revolutionary hero, President Hadley of Yale has said:

" One man's life formed the connecting link between the political revolution of the last century, and the industrial revolution of the present."

To this statement may be added " that one man's life is the connecting link between the beginning of railroad construction and its present wonderful development and expansion."

It is needless to emphasize the importance of railroads to the life of this country. They are the recognized great agencies for transportation, by means of which the products of the field, the forests, the mines, the shops and the factory are transported from one section of the country to the other.

While we have outlined the early developments, let us glance at some of the figures for the last two decades in the United States, covering a period which no doubt everyone within the hearing of my voice has been actively engaged in the railroad service:

INCREASES FROM 1889 to 1909.

	1889	1909	Increase per Cent.
Miles of Line,	153,385	234,182	52.7
" " Track,	195,958	340,000	73.5
Net Capital, etc.,	$7,366,745,000	$13,508,711,000	83.3
Pass. Carried,	472,171,000	880,764,000	86.5
Tons Freight Carried,	539,639,000	1,486,000,000	175.3
Loco. Number,	29,036	57,220	97.
Frt. Cars Number,	829,885	2,113,450	154.6
Employees Number,	704,743	1,524,000	116.2
" Compensation,	$389,785,664	$1,003,270,000	157.4
Electric Railways,	0	50,000	

In analyzing this wonderful railroad development one is impressed with the efficiency of the organization which has accomplished it. There is no field of human activity wherein the value of organized effort by a division of labor, working to a common end, is made more manifest than in the railroad service.

In the construction, maintenance and operation of a railroad, there is required many kinds of talent of the highest order. The engineers, who survey and locate, those who design the bridges and build them, the mechanics who design and construct the locomotives and cars, and the operators who run the engines, the traffic, financial and operating officials have all been experts in their several lines of work, and made possible this wonderful railroad development.

The railroad membership of this Club represents almost every division of talent referred to, and a great many have been actively engaged in this great development.

These introductory words places before us not only the facts referred to in the development of this gigantic system of transportation, but the further facts that by reason of such fast development in the last decades, especially in the locomotive and car departments, that there must of necessity be some weak links in the chain that we are now obliged to consider and strengthen, and in doing so we fully believe that the knowledge we gain through analysis, together with the physical tests, are the agencies that will help us to solve some of the hard problems of the day. I fully recognize these agencies are being used to some extent, but am convinced they are used only in a small degree in comparison to what they should be.

At first thought, one would hardly realize the necessity of a chemical analysis of the material entering into the track, bridges, locomotives and cars, but when we pause in our mad rush of competition and strife, and consider that in the last twenty-five years the increase in our power and cars places upon our tracks and bridges, as well as upon the locomotives and cars themselves, a burden that at once must attract the attention of those responsible for the safety of the property and the human freight carried over these roads at a greatly increased speed, it is then that we appreciate the need of assistance of analytical science.

It is a well known fact that the weight of our rolling stock has increased enormously during the last decade. Reference to a tabulation of locomotive weights show that the typical American Passenger and Freight Engines have increased 90 to 100 per cent. since 1889, both in axle load and total weight on driving wheels.

The locomotive weights have been considered of first importance in deciding upon the type and weight of rail that is to be employed on account of being heavier than cars. The weights of cars, however, should be given more consideration, as the load is more concentrated than those in locomotives, because of the smaller diameter of the wheels, especially since the change of type in locomotives, increasing the number of driving wheels, thus distributing these increased loads.

These startling increases, together with the increase in speed, clearly indicate the necessity of strengthening our tracks and bridges by increased weight, and particularly in the quantity of material entering into their construction, and here is where the wise manager knows by analysis what to specify, and if his purchasing agent is getting the quality specified.

Twenty years ago, when the thought of scarcity of timber rarely entered our mind, at which time you could purchase the best of white oak ties at 50 cents each, the use of a pine tie and chemical treatment to preserve and lengthen their life was a subject of no particular interest, but today, with the scarcity of timber suitable for cross-ties, consequently high cost, coupled with the great subject of conservation of our forests, a subject which has been pushed to the front by the president of our country, and is attracting the attention of our best statesmen, the chemical treatment of our ties is being greatly augmented. Many of the railroads have already gone into this very extensively, and when the value of this chemical treatment of our timber is more fully appreciated, the more it will be practiced.

The wooden trestles and bridges of early days of railroading are being replaced by steel and concrete. This is truly an age of concrete and steel, not only with the railroads, but in general construction; hence, the importance of knowing the component parts of the steel and quality of cement that enter into our bridges, and to know by analysis that they are up to the required standard, necessitates the service of an expert chemist, without which you are left at the mercy of competitive manufacturers, many of whom make their products the cheapest known way, placing them on the market at a lower price, which catches the eye of the average purchasing agent.

Other manufacturers again employ the service of expert metallurgists and chemists, and are giving to the users of their products the benefits of such expert service, but unless you are equipped for checking analytically the difference in your purchases, you will in time, and that shortly, fully realize the folly of your economy, because the purchasing agent, and, yes! the management is more than likely to purchase the article carrying the lesser price, regardless of quality.

We have but lightly touched on the sub-structure of our track, as we desire to say just a word on the super-structure, as that seems to be the point of attack, the generally supposed weak point in the track the one to which the cause of accidents are attributed, the steel rail.

It is not my purpose to attempt to talk on the chemical analysis of steel rails, as the subject is one that has been under discussion and consideration for many years by both the manufacturers and the users. There has been volumes written on this subject by the brightest minds in the steel business, coupled with all the best expert railroad engineering talent that this, and all other countries possess. They have joined forces in an endeavor to solve one of the greatest problems in connection with the safety of railroad operations. You also had a very elaborate, highly instructive and interesting paper on this subject about two years ago, giving in detail all that could be said from the manufacturers' standpoint, therefore, anything I could add would be but infinitesimal, compared with the literature now at your command, of which, no doubt, a great many of you are very familiar.

The analysis of the subject, however, is interesting from an operating standpoint when we consider it in connection with the greatly increased burden placed upon the rail, in comparison with the greatly increased weight of the rail itself. I will again refer you to the figures showing that the locomotive and car load has more than doubled, and the speed equally so, yet the standard rail sections have been increased only about 20 per cent., and I think I am therefore safe in repeating: " Just at the present time we seem to have reached one of the transition periods in the manufacturing and use of steel rails, in which the rails as made, do not quite balance with the railroad traffic as it exists in all places."

This is acknowledged by some users, and it has been said with truth, that the increase of the section of the rail is something that comes about very slowly, and very gradually, in fact, it has increased only about ten to fifteen pounds per yard, as against an increase of three times in the wheel load.

One user says: " We must admit that in the desire for tonnage, for large and paying traffic, the railroads have increased the size and weight of cars, they have increased the size and weight of locomotives, and the speed of the train almost doubled, while at the same time they have allowed the weight of their rails to lag behind, and have not increased their size and strength to be standard of present day requirements."

There is not a little difference in opinion between the makers and the railroads as to the quality of the rails made today, but we do know that they are co-operating to the end of a revised and safe section. The complaint of broken rails, especially those failures which are the result of piping, the responsibility of which rests with the manufacturers, is receiving a great deal of attention, and it is the belief that great advancement is being made in correcting this one particular cause of rail failures. Experiments and tests have been made with good results by the use of an alloy of ferro-titanium in the bessemer rail steel.

The writer is now putting down about one mile of test track, in which a ninety pound section ferro-titanium rails are laid on oak ties, hook shoulder tie plates, the Abbott Joint plate, and stone ballast. This is laid on a little better than 1 per cent. grade, varying from a tangent to 12° 26′ curvature, giving an excellent opportunity to test straight away lead wear, as well as side wear, due to the curvature. As an exceedingly heavy traffic passes this point, the wear, which will be subject to all tests, except high speed, will afford a thorough test of these rails, and the results will be looked forward to with much interest. A given period of the tonnage and wear will be kept, and a comparison made with the regular bessemer rail. " There is not a piece of steel made for any structure whatever, that has to withstand such severe treatment as that imposed upon a rail," and I feel safe in adding one that is given less consideration when once in the track, which may be interspersed with oak and soft wood ties, the soft wood with a steel tie plate, and the tie plate being absent in the oak ties, producing in the case where the tie plate is used, in very cold weather, an unyielding spot that takes an undue proportion of the blow from the rolling equipment. Take this condition and multiply it by any number of equally aggravated conditions, such as off-counterbalanced engine (mentioned later), together with flat wheels, as in a case under my own observation, when a heavy consolidated locomotive, with spots from three to five inches on every driving wheel was run in this condition over one hundred miles in train service, and you are certainly expecting from the unbalanced rail a service which no steel will withstand.

This Club has had papers on the economical use of locomotive fuel, and these papers, and the discussions that followed, have been instructive and interesting; profitable to the Club and to the users of fuel. At the May meeting of last year, when this subject was before the Club, the statement was made by one of the members, representing one of the railroads entering this City, that one shovel (16 pounds), of coal saved for each engine mile would result in a saving in a year, on his road, of enough coal to fill 1,000 fifty (50) ton cars. That would mean an annual saving of 100,000 dollars. He further stated that with good firing that saving would be an easy proposition. To accomplish this, you first have to interest hundreds of firemen and engineers, many of whom have no interest, only to get over the road and meet the paymaster twice a month. I fully believe in, and have caused to be put into practice, the education of our firemen and engineers, and impressing upon them co-operation to the end of economical use of the greatest items in the cost of the operations of our roads—another commodity in the subject of conservation—but I think I am safe in saying up to the present time this burden has been placed almost wholly upon the men on the engines. We expect them to haul big trains, make their time, and do it with the least possible expense as to fuel. I believe we have many men on our engines who are practicing fuel economy and in every way working hard for the best interests of their superior, feeling that their superior also has their interest in mind, yet these men are blamed for not producing the desired results, when in fact the blame, and their trouble lies at the door of their superior in not knowing by chemical analysis that the purchasing agent is buying a good quality of coal instead of anything that looks black and calling it coal, and imposing on the men on the locomotives an impossibility. The analysis of coal is no new idea, and for years the fuel used for metallurgical processes has been analyzed for the impurities that are detrimental to iron and steel, but it is only quite recently that the United States Government, and some other private steam coal users, have taken up the systematic analysis of coal, and make their purchases on analysis and specification. In fact the coal consumers' only means of economical results is the frequent analysis of his fuel. The different materials that are usually determined in coal are the moisture, volatile, fixed carbon, ash, sulphur and heating value, or heat units. For locomotive fuel, heating value, ash, moisture, and sulphur are probably the things that would be taken into consideration. All coals are invested with more or less heating value. The heating value is generally expressed in B. T. U.'s, or British Thermal Units, and is of very great importance in comparing different kinds of coal.

The economic value of a fuel is affected by the actual amount of combustible matter it contains, as determined by the heating value shown in British Thermal Units per pound of fuel, and also by other factors, among which is its ash contents. The ash contents not only lowers the heating value, and decreases the capacity of the furnace, but also materially increases the cost of handling the coal, the labor of firing, the cost of removal of ashes, etc.

Each B. T. U. marks the amount of heat that is required to raise the temperature of one pound of water, one degree Fahrenheit, when the water is at its maximum density. In Bituminous coals of the highest grade the number of heat units to the pound will range about 16,000. In the lower grades the units will often number less than 10,000. Ash in coal used for steam fuel vary from 5 to 35 per cent. Each per cent. of ash means to each ton of fuel a twenty pound loss of combustion. Also each per cent. of moisture means another twenty pounds loss of combustion, and is expelled only at the cost of still more carbon.

Analyze, if you please, what it means to the consumer of a large tonnage of coal, that costs, say, $2.10 per net ton. Take a coal which contains only 12,000 B. T. U.'s as compared with one of 16,000, and your loss represents 25 per cent. To this add for high ash, say, 4 per cent., or 80 per cent. loss per ton. Again make a further addition of, say, 2 per cent. for high moisture, and you have an aggregate of 31 per cent. loss of your coal at $2.10 per ton, representing .651.

I will ask you to compare your loss by poor firing to this loss in the purchasing of your coal without analysis or specification. Take the above, using what I consider a very conservative example, and see if you do not find through this agency of analysis a far greater factor of economy than through the fireman. After you have purchased your coal on specification, and have effected a saving thereby of 25 to 35 per cent., you still have the same opportunity to further increase your savings by the education of your fireman. The writer has experimented not a little with the different kinds of steam coal used during the last few years, and has demonstrated to his satisfaction that the analysis proves out in the actual operation. We have not only had the analysis of the coal, but have weighed the coal when placed on the tenders thus checking the quantity consumed, the result showing 20 to 30 per cent. difference in the several grades in quantity consumed. I might add that the loss from inferior quality shown above is not the only point to be considered, for a coal high in sulphur, producing clinkers, resulting in the loss of engine service for the time it takes to clean the fire, and this means from 12 to 24 per cent. for each 12-hour shift.

I am taking too much time in specifying items where the benefits are derived from analysis, and in hastening, wish to say that these benefits by analysis can be traced through every department, and material used. If the master mechanic finds a particularly good wearing set of tires, he is no doubt anxious to know for a certainty what the constituents are that make them wear well, in order that he may be in a position to know just what to specify on the next order. He submits his sample borings to the chemist, who gives him the manganese, carbon, silicon, etc., and thereby puts him in a position to get more of the same quality of tire steel. Again he may find a shop tool that the first cost for material was but a few cents, but on which the labor may have been dollars break in the first using, while another tool, made by the same "Smith," stands, good, hard wear. He does not know whether it was the steel or the blacksmith, but having no easy way of determining, he continues making the tools, placing the labor on what he could have easily found by analysis, after the first tool proved defective, to be poor steel, thereby saving the labor expended on the poor steel.

What is true of the master mechanic, is equally true of the Master Car Builder. His practice shows good results which he takes for granted, but when he has his troubles with sheared coupler rivets, or broken draw bolts, he is prone to say it's rough handling, and the General Yardmaster is most likely to get a letter very mildly calling his attention to the fact, but an analysis of the iron in the bolts would have surprised the Master Car Builder, when he found his trouble was due to red short iron.

I know of an order placed a few days ago for steel for knuckle pins, and I was asked what grade of steel was suitable for that purpose. This Master Car Builder may, or may not, get just what he wants, but had he been in a position to have specified the chemical analysis of the steel ordered, he would have been more liable to have received an article just suited to the service for which it is to be used. The maker may not always know what the steel is to be used for, or even if they did, they may not be versed on the requirements for that particular service. Too, the order may simply pass through an order department and through the hands of clerks who specify so many tons of soft coal. Possibly some roads do make analytical tests and specify, but I believe the greater number do not, and the cars owned by those who do not, travel from one end of the country to the other, and the pains-taking roads are obliged to handle the other fellows' cars, consequently are caused to suffer loss and delay by reason of that other fellow's neglect.

We have reached a point in the car building when nearly everything is steel, and the proper protection of steel is one of the problems with which we have to deal. I think we all agree that unless the steel is protected with a preserving coating, and kept from the oxidizing effects of the atmosphere, and in the coal car, from the action of sulphurous fumes, or acids in the coal, that the car will be of a comparatively short life. Therefore, it is a question of paint of the right quality. The same is true of our bridges, and other steel structures, without which your cost of maintenance is sure to be high.

One writer, in an article on paint legislation before the American Society for testing materials, said: " It is unfortunate that some of the mixed paints have so little of merit, *but how are the public to separate the* *good from the bad?* I am, I believe, prepared to show that about 80 per cent. of the manufacturers of paint are misrepresenting the facts to the public, they are deceiving them, misleading them, and in not a few cases, defrauding them. With competition so fierce as has been the case within the past years, it is safe to say that paint manufacturers have not as a rule produced a paint as good as they know how to produce—unfortunately there are many other manufacturers producing paint as cheaply as they can, and with little regard for the wearing qualities as the first consideration, paint, for example, in which 75 per cent. of the liquid portion is without any merit whatever, being chiefly water and benzine. I would not for a moment have it understood that I believe that all manufacturers of paint resort to unfair methods—far from it."

It is generally conceded that paints made from one formula for use over the entire country will not give to all good results. Hence, a particular brand of paint ready mixed that works well in Buffalo would give poor results in New York. To get good results over the entire system of your railroads, isn't the solution Analysis, and the specification of a brand of paint to suit your varied conditions?

We could multiply without number places where by the use of chemical analysis the reduction of operating cost would be most manifest, and same of the larger systems recognize this fact and maintain a well equipped laboratory and staff large enough to cover every commodity purchased.

Further we have the American Society for Testing Materials made up of a membership of our brightest scientific men, but its membership to a very great degree represents the manufacturers instead of the railroads. On the other hand the railroads are represented in the American Engineering and Maintenance of Way Association, but these representatives of the railroads do not, if any information is correct, go into a general analysis of the several railroad departments, but deal more particularly with Maintenance of Way. All the work of these Associations are most beneficial, as is the work of kindred societies, and furnish a flood of information, yet there is much necessary data that we must have, that can come only through a fully equipped chemical laboratory.

ANALYSIS OTHERWISE.

The extent to which analysis otherwise is used by the railroads especially in the last decade, is of interest, if not surprising. We find it used from the president down through the line in every branch of the family tree, yes, even to the " stove committee."

The president is looking for a bright hustling man for superintendent of some particularly hard division. Finally he gets his eye on such a man through recommendation, or a still hunt. The first thing he does is to analyze the man. He applies the manhood test to ascertain if his past and present life is up to a standard that will recommend him to the executive board when his name comes before them, and also to satisfy himself that he has those gentlemanly qualities that will entitle him to become one of the official family, who must of necessity be taken into the inside secret workings of the system. Having satisfied himself in that particular, he goes further in his analysis as to his experience and executive ability, also if he is a leader of men—a most important qualification these days—if he is a diplomat, that his contact with the patrons of the road and the general public will create that general good feeling, which is to-day, if not in days gone by, recognized as an essential qualification by the heads of the large railroad systems of this country, as any qualification a superintendent may possess. In fact, it is now considered essential in every department, and the presidents are giving very gentle, but positive hints, as to what is expected of all employees.

After the president has satisfied himself on those points, and the superintendent has been installed and has had sufficient time to put his methods into practice, what does the president then do? Why, he simply renews his analysis by analyzing his payroll costs, percentage of business handled, compared with previous records. If this president does not take the pains to apply analysis to purchased material, why does he do so in this case; is one more essential than the other?

If that superintendent is possessed with the qualifications that the president's analysis credited him with, it is not necessary to speculate as to what that superintendent is doing at the same time, as without doubt, he is applying the same analysis to this, or that head of department, as was used by the president in his case. Why?

The superintendent of motive power not only analyzes his master mechanics, master car builders, and the whole force, but when his assistant places before him a design, say, for a new locomotive, he at once proceeds to analyze it. He must know before placing his approval to the drawings that it is in every particular a properly balanced engine; that it has the required heating surface to generate steam for the size cylinder specified; that the weight is properly distributed between each pair of driving wheels and truck; that the driving wheels are accurately counter-balanced, a most important matter in the design and construction of locomotives. The counter-balancing is not only necessary, but of vital importance, as it has been acknowledged that an unproperly counter-balanced engine is the cause of many broken rails, which may result in great destruction to property and person. To emphasize this, you will please bear with me that while I point out that from 1885 to 1907 the axle load has increased from 24,000 pounds to 53,500 pounds, an increase of 123 per cent. The average weight on drivers has increased from about 60,000 pounds in 1885 to over 180,000 pounds in 1907. In connection with these great increases, and in looking for the cause of broken rails, one writer has said: " I have investigated a number of cases, and find same due to an impact blow from an off counter-balanced engine—I have had occasion recently to compute the impact blow delivered by an off counter-balanced engine running at a speed of ninety miles an hour, although it was one of the latest types of engines, yet at one point in the revolution the minimum pressure on the rail was 4,000 pounds, and at another point the maximum pressure was 57,000 pounds. This enormous pressure is distributed over an area of only about ½ square inch, hence, you can see what a tremendous blow can be delivered in high speed traffic. This is assuming that the roadbed is in perfect condition. When you take into account the irregularities of the track, such as are due to the freezing of the ballast and the rolling of the engine due to this irregularity in the track, the maximum pressure delivered by an off counter-balanced engine must be far higher than that which I have computed."

Another speaker on the same subject said: " Upon the rail there is all the increased effect of suddeness of application, and also other stresses due to vertical oscillations of the load. We need only to recall the beautiful experiment made by Professor Goss, in which a wire was run underneath a driver wheel, a portion of the wire being crushed, and another portion not, indicating that the entire wheel had been elevated by an improper counter-balance."

That the builders are liable to give you an off counter-balanced engine I know from experience. I purchased several switch engines that were wanted in a hurry, accepting a design and pattern which was said to have received a great deal of thought not only by the builders, but by a superintendent of motive power of one of our largest trunk lines, but when these engines were received they were so badly off counter-balanced that you could not keep a chimney on the rear headlight. In fact, you could feel the effect of this off counter-balancing four or five car-lengths from the engine. I leave it to you to imagine what a blow that would give the rail, and there are no doubt hundreds of engines with the same defects in heavy road high speed service today, simply because the superintendent of motive power did not give them the proper analysis before placing his order.

The Superintendent of Motive Power thus analyzes his power part by part. Is this an unnecessary expenditure of labor on his part? I ask this question for the reason that I heard a gentleman complaining of the red tape of the present day, as compared with old time methods when the superintendent simply said, " I want so many new freight engines," and he got them, while today it takes months to get the order to the builder.

In like manner the Master Car Builder analyzes his cars. At the last convention of Master Car Builders it was stated on the floor that there was a scarcity of good men in the car department that were capable of filling positions as superintendents of large shops, which means men that are qualified to analyze a car, and know that its proportions are right and parts sufficiently strong to carry the increased load that has been pointed out. From this statement, made by one qualified to speak, it seems to me that right here is a hint to the young men in the car department, who are ambitious and anxious to reach the top, and we have 31 General Car Shop Foremen in our Club—to analyze themselves and see what is lacking, and acquire that one thing.

The Train Master in hiring his men for train service, or the Master Mechanic for engine service, practices this analysis in both physical and mental qualification of all applicants, in fact, it is recognized by all roads as positively necessary for the best interest of the road and the traveling public, that men must be possessed of certain qualifications before they are placed in these responsible positions, hence, this examination or analysis.

While this analysis was not considered as necessary in the early period of railroading, no doubt you gentlemen know why it is today, and will tell us.

During an inspection of terminals around Buffalo a few weeks ago, the speaker saw three general yardmasters off by themselves in one end of the coach analyzing their costs, evidently that each would be in a better position to explain to their superior officer why the cost per car was higher than heretofore. Was it increase in wages, increased tonnage carried per car, or what? These same general yardmasters, without doubt, analyze terminal layouts, track facilities, kind of power assigned them, and the time and manner it is given to them; also delays by passenger and other traffic, possibly, too, they may find in their analysis that inspection and handling of bad orders have a bearing on their costs.

Truly, this is an age of analysis, especially in the railroad circles, and the problems of the day, such as the labor question, increased operating costs without a corresponding increase in freight rates, are problems that the heads of the great transportation systems are struggling under, and by analysis are trying to master the situation. The more complete the analysis by these heads, the further it spreads down the line, until I think we can safely state that there is no department but what practice and feel its effects.

While analysis is being applied to, and by different departments of the railroads, we must not forget that there is, if not what may be considered a department of the railroad, an allied interest largely made up of railroad men, which is subject to analysis by several different interested parties, and each from a wholly different motive; I refer to the Central Railway Club.

The writer of this paper felt a desire to know of just what the Club, as to railroad membership, was composed, therefore, has analyzed it, and as it may also be of interest to others, you will find below the result of the partition:

Vice-Presidents, 2; Asst. to President, 2; General Manager, 1; General Superintendents, 2; Superintendents, 7; Asst. Superintendents, 2; General Superintendent M. P., 1; Superintendents M. P., 8; Asst. Superintendents M. P., 1; Master Mechanics, 14; Master Car Builders, 11; Superintendent Transportation, 1; Elect. Engineer, 0; General Foremen Car Dept., 31; General Foremen Loco. Dept., 24; Asst. Foremen Car Dept., 3; Rd. Foremen Engines, 8; General Inspectors, 16; Chief Inspectors, 2; Foremen Boiler Makers, 2; Foreman Blacksmith, 1; Foreman Roundhouse, 1; Chairman Freight Car Part, 1; Arbitrator, 1;

Boilermakers, 2; Mechanical Engineers, 3; Draughtsman, 1; Superintendent Signals, 2; Asst. Superintendent Maint. of Way, 1; Roadmaster, 1; Master Plumber, 1; Air Brakemen, 6; Foremen Painters, 2; Trainmasters, 8; Asst. Trainmasters, 1; Train Despatchers, 3; Engine Despatchers, 1; General Yardmasters, 4; Yardmasters, 9; Car Accountant, 1; Auditor, 1; Station Master, 1; Chief Clerks, 17; Clerks, 2; Agents, 9; Secretary, 1; Chief Wrecker, 1; Chief Inspector Bureau of Streets, 1; Surgeon, 1; Conductors, 2; Locomotive Engineers, 65; Locomotive Fireman, 2; Storekeepers, 4; Purchasing Agent, 1; Chemist, 1; General Freight Agent, 1; Division General Freight Agent, 1; Paymaster, 1; Sales Agent, 1; Freight Solicitor, 1; Manager Car Service B, 1; Wreck Inspector, 1.

We also have supply and material men representing heads of locomotive and car works, constituting the very best talent in this country which also would make a strong Club in themselves.

Like every organization it has its full equipment of offices. By-laws, rules, and reason for existence, and may be fulfilling its missions, however, it cannot escape the analysis referred to. Who are the analysts?

First we have our superior officials, busy men, not members of the Club, nor readers of its proceedings, and probably know very little of the work that has been accomplished in the past. They do know, however, that they have a goodly number of men on their pay-rolls who are away from their work four or five times a year in attendance upon meetings, or at an outing—as we are today—and they undoubtedly analyze us to find out if the company is being benefited, or getting anything in return for the loss of time of these employees. There are, no doubt, varied conclusions reached—and I know some not particularly favorable to the Club. Again we have several manufacturers of railroad supplies, who are giving us twenty to eighty dollars per year for advertising space. Are we analyzed by them? If you cannot answer from personal knowledge, just go out and solicit advertising, and you will be fully qualified to testify. I think your Secretary can tell you something about that.

That you will not altogether arrive at wrong conclusions, I will answer the question from one viewpoint. I heard one man who has advertised in the Official Proceedings for several years say a short time ago, that he was advertising in nearly all the railroad periodicals, and to his mind the different clubs' proceedings was the best of them all; that he had made an analysis and felt qualified to speak.

This certainly must be gratifying to the Club, but has it occurred to us that it might be well for each of us to analyze the Club, what it has accomplished, what it is now doing? What are we giving our superiors for the time we spend here, and those who advertise in our Proceedings; also the future possibilities for a greater work? Further, what we individually are doing to build it up, to give each other the benefit of our experience and research, also to give it a place in the railroad clubs, second to none.

A glance at my analysis above, will show that this club has many analysts, some professional ones. Our president is one so classed, as a prominent member of the Employer's Liability Committee of New York. He is spending not a little time analyzing the labor question, and what the railroad in their several departments are doing for the protection of their employees. So, too, our Vice-President, is another. He is one of the analysts who are making it their particular business to analyze the railroads. If the railroads want to issue more bonds or stock they cannot do so until this analysis is compiled, and perhaps not then. They analyze our engine failures, thereby determining whether the cost is chargeable to the operating official who keeps the engine out when the Master Mechanic says she should go in the back shop; or whether she fails for lack of steam on account of the poor quality of coal the purchasing agent has bought at a bargain counter, or whether from leaky flues which the engineman reported, and the slips are marked O. K. when the work is not done. In short, are doing for the railroads, i.e., getting a correct record of engine failures, what the writer, Mr. Buell of the paper before this Club January, 1908, on " Some joint problems of the Mechanical and Operating Developments of a Railroad," intimated the railroads could not do for themselves. Then comes along our worthy Vice-President, and analyzes all of our equipment, and facilities for repairs, and writes us up, so we can't fool our superior by colored reports.

We have other professionals, viz., our genial, Manager Freight Car Repair Pool and our Frontier Arbitrator, who are continually analyzing. Our chemist who is a " Force " in himself. Not a few Master Mechanics of marked ability, whose pleasure it is to be thus engaged for the benefit of this Club; then, too, high Operating Officials, and expert terminal men. Outside of the railroad contingent, we have many, representing interests that have to do with supplying the railroads with much of their material of the high standard required, such as the Gould Coupler Company, who, I note by the Railroad Age Gazette, lately installed a mighty 1,200 ton hydraulic press for making axles of all kinds, and claim these new process axles, based on a carbon content of 35 per cent. give you an axle with an increased stencil strength of 25 per cent.; greater density, etc., thus giving to the railroads that quality which is necessary in the construction of locomotives and cars to safely carry the increased loads I am sure they will want to tell this Club all about it. We also have many others that are prepared to give us papers of great interest and value, in fact, set things humming, if we could only persuade them to give us the benefit of their knowledge.

In preparing this paper, I have in no way intended to make it a technical article, but simply to throw out a hint here and there to be picked up by the different talented members of the Club for future papers, or in the general discussion, as it is recognized that our most interesting meetings have been those in which there has been free expression on the part of all its members.

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